January 7, 1858.

J. P. GASSIOT, Esq., Vice-President, in the Chair.

The following communications were read :—

I. "Remarks upon the Magnetic Observations transmitted from York Fort in Hudson's Bay, in August 1857," by Lieut. BLAKISTON, of the Royal Artillery. By Major-General SABINE, R.A., Treas. and V.P.R.S. Received December 16, 1857.

In the spring of 1857, Her Majesty's Government, designing to send an expedition to examine and survey the yet unsettled country north of the boundary-line between the British territory and that of the United States, and comprised between Canada on the east and the Rocky Mountains on the west, notified their intention to the Royal Society, and invited suggestions regarding any objects of physical research, for which the Royal Society might deem this to be a fitting occasion.

Amongst the subjects to which attention was called in the reply, the expediency of confirming and extending the Magnetic Survey of British North America, which, at the instigation of the Royal Society, was made in the years 1843 and 1844, and of which the results are contained in the 'Philosophical Transactions' for 1846, Art. XVII., was not forgotten; and Lieut. Blakiston, of the Royal Artillery, personally known to Mr. Palliser, the conductor of the proposed Expedition, having been appointed to the special charge of the Magnetic Observations, and to assist generally in Geographical Determinations, the Royal Society undertook to provide the instruments suitable for the purpose, and with the sanction of the Committee of the Kew Observatory of the British Association, placed their preparation under the superintendence of Mr. Welsh, Director of that Observatory, where also Lieut. Blakiston received instructions for their use, and acquired practical experience in their manipulation. About the middle of June, Lieut. Blakiston sailed in the Hudson's Bay Com-

pany's ship the 'Prince of Wales' for York Fort, where he arrived on the 16th of August, and after completing the Magnetic Observations which he had been charged to make at that station, proceeded on the 30th of the same month, by the canoe route, to join Mr. Palliser, who had quitted England some days before him, and had taken the route by the United States to Canada and the Red River Settlement, and thence to Carlton House, where the whole party would be assembled in the fall.

The care which Lieut. Blakiston bestowed upon his determinations at York Fort appears to have been commensurate with the theoretical importance which, before he quitted England, he was aware would attach to the results. In submitting these to the Society, I must solicit a continuance of the patience and indulgence so kindly given to me on a recent occasion; for the subject of Terrestrial Magnetism is far less generally understood than I believe it deserves to be; and there is often an apparent complexity in the details, especially to those who are not familiar with the subject, which requires time to be occupied in their elucidation. I shall commence with showing the confirmation which Lieut. Blakiston's results give to the approximate accuracy of the value assigned in the 'Philosophical Transactions' for 1846, for the absolute magnetic force at its principal point of maximum in the northern hemisphere.

Those who are conversant, either from personal recollection or as a matter of history, with the opinions regarding the phenomena of terrestrial magnetism entertained in the first quarter of the present century, will scarcely need to be reminded how generally the belief then prevailed, that the magnetic dip and the intensity of the magnetic force at different points of the earth's surface might be represented with at least a sufficient approximation by mathematical formulæ, obtained by supposing the magnetism of the earth to be concentrated into two magnetic poles, very near to each other and to the earth's centre; the supposition being also equivalent to that of an infinite number of small magnets parallel to each other, distributed equally throughout the earth's surface. According to this supposition, the greatest intensity of the magnetic force in each of the two hemispheres should be found at the points where the dip should be 90°, and the intensity should vary in the proportion of 2 : 1 between places where the dip should be respectively 90° and 0°.

In the Arctic Expeditions of 1818, 1819, and 1820, I had an opportunity of measuring the intensity of the magnetic force at several stations in the immediate vicinity of the dip of 90° ; and in the years 1821 and 1822, of comparing these measures with others made at several points of the coasts of Europe, Africa, and America, and at islands in the Atlantic Ocean (which I visited for the purpose of making observations with the pendulum), in dips which, including the Arctic stations, varied from 0° to 88° 47′. The result of this comparison was to place beyond a question the irreconcilability of the phenomena with the supposition of a coincidence between the points of 90° of dip and of the maximum of force. For example, the magnetic force was found to be considerably greater at New York, where the dip was not more than 73°, than at the stations in the Polar Sea where it was nearly 90° ; and by graphical delineations, according to well-known methods, in which all the observations were taken into the account, it was shown that whilst the dip of 90° could not be in a more southerly latitude than 70°, the greatest intensity of the force would be found somewhere about the 53rd parallel in the vicinity of Hudson's Bay, not less than 1000 geographical miles distant from the point of 90° of dip with which it had been supposed to coincide.

The hypothesis, so generally put forward in the elementary treatises on Magnetism of that period, was therefore shown to be no longer tenable. It was in fact specially one of that class of speculations designated by Bacon as "anticipations of nature," of which it is so commonly the fate to be swept away, as knowledge advances by that more slow and gradual, but more philosophical and certain "interpretation of nature," which results from a strictly inductive process.

Steadily pursuing this last-named process, the Royal Society—after provision had been made by the establishment of Colonial Magnetic Observatories for a systematic examination of the phenomena of the variations of comparatively small amount, which are produced at the surface of our planet by the influence of other bodies of our system; and by the Antarctic Expedition of Sir James Ross, for the magnetic survey of such portions of the higher latitudes of the southern hemisphere as are accessible to navigation,—recommended to Her Majesty's Government, that in the northern hemisphere a magnetic survey

should be made of those parts of the British possessions which were adjacent to the position which observation had indicated as that of the principal maximum of the magnetic force in that hemisphere. This recommendation was carried out in 1843 and 1844, and the particulars of the survey, together with the conclusions derived from it, form No. VII. of the magnetic contributions in the 'Philosophical Transactions' for 1846, Art. XVII. The geographical position of the maximum of magnetic force derived from the combination of the 78 stations of that survey was 52° 19′ N. and 91° 59′ W. of Greenwich, and the absolute value of the force at its point of maximum was found to be 14·21 in British units (*i. e.* of mass, a grain; of time, a second; and of space, a foot). As both the geographical position of the point of maximum, and the absolute value of the force prevailing there, are subject to a secular variation, of which the nature, the period, and the epochs are desiderata of the highest theoretical importance,—and as the determinations which are now made may therefore probably be referred to as data by remote posterity,—their confirmation, by the observations of a second observer visiting the same localities within a few years of the same date, furnished with different instruments, and pursuing in some respects different methods, was viewed as a circumstance much to be desired by the Committee of the Royal Society appointed, at the request of Her Majesty's Government, to suggest scientific desiderata, to be accomplished by Mr. Palliser's North American Expedition.

York Fort had been one of the stations visited by Lieut. (now Lieut.-Col.) Lefroy, in the Survey of 1843–44. It is situated nearly due north of the point of maximum deduced from that survey, and less than 300 miles distant from it. The intensity of the force at York Fort in July 1843, derived from the combined observations of the inclination and of the horizontal force observed by Gauss's well-known absolute method, was 14·07; and by Mr. Fox's statical apparatus, taking Toronto as a base, 14·03. We have now to compare with these Lieut. Blakiston's results in August 1857, viz. 14·024 by the combination of the inclination and the absolute horizontal force, and 14·017 by a recent improvement of Dr. Lloyd's statical method, which renders the result independent of changes which may take place in the magnetic moment of the needle employed in the determination. The first of these two last-named results has been computed by Mr.

Welsh, of the Kew Observatory, from the observations received from Lieut. Blakiston, who was too much pressed for time by his approaching departure from York Fort to compute them himself. The second is the mean of five determinations on three different days, which were computed by himself on the spot; they are severally as follows:—

August	20th, noon	14·03
,,	20th, 3 P.M.	14·01
,,	22nd, 5 P.M.	14·024
,,	24th, noon	14·00
,,	24th, 3 P.M.	14·02
	Mean	14·017

We have therefore by the mean of the two methods in 1843, 14·05, and by the mean of the two methods in 1857, 14·02, differing only about $\frac{1}{470}$th from each other. As far, therefore, as agreement *at a single station* may be regarded as confirming the conclusions of the survey of 1843–44, Lieut. Blakiston's results furnish that confirmation; and judging from the result at the first station at which the comparison has been made, we may anticipate, from the opportunities which he is likely to have of repeating observations at other stations of the former survey, as well as of adding stations previously unvisited, that the ultimate conclusion in respect to the absolute value of the magnetic force at its point of maximum at this particular magnetic epoch, will be as perfect as could be desired. With respect to its present geographical position, we may also hope that Lieut. Blakiston may have an opportunity, before his employment is terminated, of removing any doubts that may exist as to the precision of the *longitude* assigned to it by the survey of 1843–44. It cannot have escaped notice that the 78 stations of that survey, which by their combination assigned the latitude and longitude of the point of maximum, did not perfectly fulfil one important condition regarding their distribution, viz. that of symmetrical arrangement on all sides of the point in question. There was a considerable preponderance of stations situated on the west of the meridian of the point itself, and a deficiency on the eastern side, which might have been remedied, had circumstances permitted, by a line of stations as originally contemplated on the canoe route from Canada to Moose

Fort at the south-western end of Hudson's Bay, and possibly by some additional stations between Moose Fort and York Fort. The experience which Lieut. Blakiston has had in canoe-travelling will have prepared him to profit by the opportunities it may afford for observation, and the route referred to is one of the ordinary canoe routes of the Hudson's Bay Company: with this addition, the determinations of geographical position and of the value of the magnetic force at its point of maximum, may be expected to be amongst the most perfect, as they will undoubtedly be amongst the most important data, in this great branch of Physical Geography.

I proceed to notice Lieut. Blakiston's observations upon the magnetic declination at York Fort, which, taken in conjunction with those of the survey in 1843–44, tend to substantiate conclusions of no less theoretical importance than those with which we have been occupied regarding the magnetic force. It is well known to those who are conversant with the phenomena of the *secular change* of the declination, that during the whole of the last century, and for some time after the commencement of the present century, the secular change which took place in the position of the isogonic lines in the northern parts of the North American continent, consisted in the progressive translation of the lines from west to east. The line of no declination, for example, to which, when Halley collected and coordinated the most trustworthy observations previous to the publication of his Magnetical Map in 1702, he assigned a position "about the meridian of the middle of California" (Phil. Trans., No. 148), appears in Hansteen's 'Mappa hydrographica sistens Declinationes magneticas Anni 1787' (Erdmagnetismus, Atlas), at the latter epoch, as crossing Lake Superior, and proceeding from thence in a direction west of north, so as to pass altogether to the west of any part of Hudson's Bay; whilst from well-assured observations of a still later date we know that soon after the beginning of the present century, places situated on the western shores of Hudson's Bay had *east* declination, showing that the line of no declination had passed over and was now to the east of them. Consistently with this general movement of the isogonic lines from west to east, the declination at York Fort, which, according to the observations of Capt. Middleton (Phil. Trans. 1726, No. 393, and 1731, No. 418) was at least 19° West in 1725, had diminished to about 5° West in 1787 (Hansteen, *l. c.*). In Septem-

ber 1819 it was found by Sir John Franklin to be 6° *East* (Journey to the Shores of the Polar Sea, 1819–22, p. 26), and by Lieut.-Colonel Lefroy in 1843, 9° 25′ East. Thus we perceive that in little more than a century (from 1725 to 1843) the declination at York Fort had changed progressively, by the operation of secular change, not less than 28°, always in the direction of westerly decreasing or easterly increasing; (which is in effect the same as a movement of translation of the isogonic lines from west to east).

In 1841 the Toronto Observatory commenced its observations, and although (from defective instrumental organization) the conclusions in regard to the secular change of the declination were not *at first* as precise as could be desired, they were sufficiently so to justify a strong persuasion that some very notable change had recently taken place in the order of the phenomena, and to lead to the commencement, in January 1845, of a special series of monthly determinations in a detached building, appropriated chiefly to a close investigation into the direction and amount of the secular change. The result is stated in the 3rd volume of the Toronto Observations, p. cxxvi, and is as follows:—"The secular change of the declination from 1845 to 1851 inclusive was an annual increase of 1′·95 of west declination. From July 1851 to April 1854 (two years and nine months) an annual increase of 2·54: and assuming the circumstances of a new series commenced in 1855 with the same instrument placed in a new building to be strictly comparable with those of the old series, the increase from April 1854 to October 1855 is at the mean annual rate of 3′·54." The progressively increasing amount of the rate of secular change is a circumstance which, for obvious reasons, may be expected to follow for a time after the reversal of the direction of the change.

Attention being thus alive, particular care was taken that the azimuth compass with which Lieut. Blakiston was supplied should be free from instrumental error, and the practice was recommended to him of repeating observations at different hours and on different days. The following is a transcript of the report received from him from York Fort, showing how thoroughly these directions were kept in view:—

"Declination at York Fort, 1857.

	h m		° ′	
17th August,	5 30	P.M.	7 01	E.
,,	5 43	P.M.	7 21	E.
,,	6 14	P.M.	7 43	E.
20th August,	5 16	P.M.	7 41	E.
,,	5 53	P.M.	7 24	E.
26th August,	5 54	A.M.	8 01	E.
,,	6 40	A.M.	7 57	E.
,,	7 20	A.M.	7 50	E.
		Mean	7 37	E.

"Ten to twelve observations in each set, the compass being lifted and shaken between each observation."

	° ′	
The observations of Franklin in September 1819 gave	6 00	E.
Those of Lefroy in July 1843 gave	9 25	E.
Those of Blakiston in August 1857 gave	7 37	E.

It appears therefore that the secular variation which between 1819 and 1843 caused an *increase* of east declination, caused on the contrary between 1843 and 1857 a *decrease* of east declination. This is a reversal in the same sense as that which has been seen to have taken place at Toronto. It seems probable from an inspection of the intervals, and of the differences of declination-value, in the three determinations above noticed, that the epoch of reversal must have coincided very nearly with that of the survey of 1843–44; and consequently that Lieut.-Col. Lefroy's result may show approximately the maximum which the easterly declination attained at York Fort before the change took place. If we might assume 1843 to be the precise epoch, it is deserving of remark that it is the same year in which the observations of the inclination at Toronto show that the annual secular variation of that element changed from a decreasing to an increasing rate. The dip observed by Lieut. Blakiston at York Fort was 83° 53′ in 1857, and by Lieut.-Col. Lefroy 83° 47′·2 in 1843, showing, as at Toronto, a slight increase to have taken place in that element in the interval.

I am indebted to Dr. Norton Shaw, Secretary of the Royal Geographical Society, for a copy of declinations observed by Mr. Palliser in his passage between Fort William and the Red River Settlement.

It happens that four of the stations in this route, at which Mr. Palliser observed the declination in the summer of 1857, had been stations of Lieut.-Col. Lefroy in 1843–44. They are as follows :—

	Lat.	Long.	Declination. 1843–44.	1857.
	° ′	° ′	° ′	° ′
Savannah Portage.....	48 53 N.	90 05 W.	7 46 E.	6 53 E.
Fort Francis.....	48 36	93 30	9 36	9 31
Lake of the Woods	49 27	94 44	12 16	10 17
Lake Winipeg	50 28	96 35	15 30	14 25
Means.....			11 17 E.	10 14 E.

At all the stations the easterly declination is less in 1857 than in 1843–44; and on the average of the four stations it would appear to have decreased about 1° in the fourteen years.

It would be unjust to the memory of the profound and sagacious philosopher, by whom, more than 150 years ago, the facts both of the magnetic declination in different parts of the globe and of its changes were first collected and framed into an hypothesis (Halley in Phil. Trans. 1692, No. 193), if we were to fail to recognize that this reversal in the direction of the motion of the isogonic lines, in the vicinity of the principal magnetic pole in the northern hemisphere (using the term 'pole' in the physical sense in which Halley employed it), is conformable to the hypothesis which he propounded at that early date,—"to explain," according to his own words, "the change in the variation (declination) of the magnetic needle." By the supposition of a double system of the terrestrial magnetic forces, occasioning two poles or principal points of attraction in each hemisphere producing resultant phenomena in all parts of the surface of the globe according to their relative strength and proximity, Halley showed that all the apparently complex phenomena of the magnetic direction might be systematically represented; and by the further supposition that one of the two systems (the stronger one) was fixed, and the other (the weaker one) possessed a gradual and slow motion, that a reasonable explanation could be given of the phenomena of the secular change in different parts of the globe, as far as they were known in his time. At the period when this hypothesis was originated, viz. in 1692, the two poles in the northern hemisphere were considered to be situated as follows: that of the stronger and fixed

system in North America, about the meridian of the middle of California, and that of the weaker and moving system, about the meridian of the British Islands, having a progressive motion towards the east. Now as the resultant phenomena in the north of America, though influenced principally by the nearer and stronger system, would still exhibit in a slighter degree the influence of the weaker and moving system, the isogonic lines in that part of the globe should have, according to the hypothesis, a movement of translation from west to east conformably to the motion of the weaker system, until the difference in longitude between the poles of the respective systems should amount to 180°, an event which would constitute an epoch in the secular magnetic variations, characterized (amongst other circumstances) by the reversal of the motion of the isogonic lines in America, which would thenceforward take place from east to west, as the distance between the poles should diminish on the Siberian side of what Halley termed the American Pole. Now it is well known that the expedition of MM. Hansteen, Erman, and Due, across the continents of Europe and Asia in 1828 and 1829, had, for its principal object, the determination of the magnetic phenomena around the point of maximum attractive force of the weaker or moving system ; and that the position those gentlemen assigned to it in longitude at the time of this expedition was about 115° East of Greenwich, to which meridian it had progressively moved in the interval which had elapsed since Halley assigned its position near the meridian of our Islands. Fully recognizing that in the present, as in the earlier state of magnetical science we can only regard such assignments as approximate, we have still full reason to believe that about the time of the memorable expedition of MM. Hansteen, Erman, and Due, *i. e.* a few years earlier or a few years later than 1828–29, the epoch must have occurred when the points of greatest attraction of the two systems in the northern hemisphere must have passed through their greatest longitudinal distance from each other, and when, according to Halley's hypothesis, the direction of the movement of translation of the isogonic lines in the northern parts of America should be reversed, which we find to have now taken place.

I have ventured to think that these few remarks, recalling to recollection an hypothesis which was not framed without a most laborious coordination and sagacious grouping of the phenomena

which it professed to represent, and which has its place in the earlier volumes of our Transactions, would not be unacceptable to the Members of the Royal Society, of which Society Halley has ever been regarded as one of the brightest ornaments.

II. "On the Isolation of the Radical, Mercuric Methyl." By George Bowdler Buckton, Esq., F.R.S. Received December 4, 1857.

(Abstract.)

Dr. Frankland, in his valuable memoir communicated to the Royal Society, has pointed out that hydrargyro-methylium, zinc-ethylium, and analogous bodies may be regarded as formed upon the type of the metallic oxides, the oxygen of which he considered was represented by methyl, ethyl, &c. The hypothetical radical hydrargyro-methylium, $C_2 H_3 \left\{ \begin{matrix} Hg \\ Hg \end{matrix} \right.$, according to this view would correspond to numerous oxides, $O \left\{ \begin{matrix} Hg. \\ Hg. \end{matrix} \right.$

Dünhaupt and Strecker have studied and described the salts of hydrargyro-methylium and hydrargyræthylium, but chemists do not appear, hitherto, to have succeeded in reducing these bodies to the mercuric type, or in preparing the metalloids themselves.

The author has undertaken experiments with a view to the completion of this portion of their history, a brief summary of which he now offers.

Iodide of hydrargyro-methylium was prepared through the agency of sunlight, in the usual manner; and after the removal of every trace of iodide of methyl, it was intimately mixed in a mortar with finely powdered cyanide of potassium. Small charges were then introduced into flasks and distilled over the gas flame. Gaseous and solid products are formed, together with a heavy liquid, which passes into the receiver. After washing with water, and rectification over chloride of calcium, this liquid has the following properties:—

It is colourless, highly refractive to light, and almost wholly insoluble in water. When pure, it has a faint and somewhat sweetish odour. It is very combustible, and burns with a luminous flame and abundant evolution of mercurial vapour. It is very soluble in